

Beam Power Tube

CERAMIC-METAL SEALS
CONDUCTION COOLED

COAXIAL-ELECTRODE STRUCTURE
UNIPOTENTIAL CATHODE

For Use in Low-Voltage Mobile Equip-
ment at Frequencies up to 500 Mc

GENERAL DATA

Electrical:

Heater, for Unipotential Cathode:

Voltage range (AC or DC) ^a	12.0 to 15.0	volts
Current (Approx.) at 13.5 volts	1.3	amp
Minimum heating time.	60	sec

Mu-Factor, Grid No.2 to Grid No.1

for plate volts = 250, grid-No.2 volts = 200, plate amperes = 1.2.	11
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Direct Interelectrode Capacitances:^b

Grid No.1 to plate.	0.13 max.	$\mu\mu\text{f}$
Grid No.1 to cathode.	16	$\mu\mu\text{f}$
Plate to cathode.	0.011	$\mu\mu\text{f}$
Grid No.1 to grid No.2.	22	$\mu\mu\text{f}$
Grid No.2 to plate.	6.5	$\mu\mu\text{f}$
Grid No.2 to cathode.	3.2	$\mu\mu\text{f}$
Cathode to heater	3.4	$\mu\mu\text{f}$

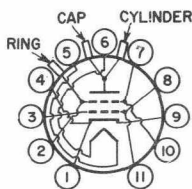
Mechanical:

Operating Position.	Any
Maximum Overall Length.	2.26"
Seated Length	1.920" $\pm$ 0.065"
Diameter.	1.426" $\pm$ 0.010"
Weight (Approx.).	2 oz
Socket.	Mycalex ^c No.CP464-2, or equivalent
Base.	Large-Wafer Elevenar 11-Pin with Ring (JEDEC, No.E11-81)

Terminal Connections (See *Dimensional Outline*):

BOTTOM VIEW

- Pin 1 - Cathode
- Pin 2 - Grid No.2
- Pin 3 - Grid No.1
- Pin 4 - Cathode
- Pin 5 - Heater
- Pin 6 - Heater
- Pin 7 - Grid No.2
- Pin 8 - Grid No.1
- Pin 9 - Cathode
- Pin 10 - Grid No.2
- Pin 11 - Grid No.1



- CAP - Plate-Terminal Connection
- CYLINDER - Plate-Terminal Contact Surface
- RING^d - Grid-No.2 Terminal Contact Surface

Thermal:

Terminal Temperature (All terminals).	250 max.	$^{\circ}\text{C}$
Plate Core Temperature (See <i>Dimensional Outline</i>).	250 max.	$^{\circ}\text{C}$



Cooling, Conduction:

The plate-terminal (cylinder) must be thermally coupled to a constant temperature device (heat-sink—solid or liquid) to limit the plate terminal to the specified maximum value of 250° C. The grid No.2, grid No.1, cathode, and heater terminals may also require coupling to the heat sink to limit their respective terminal temperature to the specified maximum value of 250° C.

LINEAR RF POWER AMPLIFIER

Single-Sideband Suppressed-Carrier Service

Peak envelope conditions for a signal having a minimum peak-to-average power ratio of 2

Maximum CCS Ratings, Absolute-Maximum Values:

	Up to 500 Mc		
DC PLATE VOLTAGE.	2200	max.	volts
DC GRID-No.2 VOLTAGE.	400	max.	volts
DC GRID-No.1 VOLTAGE.	-100	max.	volts
DC PLATE CURRENT AT PEAK OF ENVELOPE. . .	450 ^e	max.	ma
DC GRID-No.1 CURRENT.	100	max.	ma
PLATE DISSIPATION.	100 ^f	max.	watts
GRID-No.2 DISSIPATION.	8	max.	watts
PEAK HEATER-CATHODE VOLTAGE:			
Heater negative with respect to cathode.	150	max.	volts
Heater positive with respect to cathode.	150	max.	volts

Typical CCS Operation with "Two-Tone Modulation":

	At 30 Mc		
DC Plate Voltage.	700		volts
DC Grid-No.2 Voltage ^g	250		volts
DC Grid-No.1 Voltage ^g	-20		volts
Zero-Signal DC Plate Current.	100		ma
Effective RF Load Resistance.	1420		ohms
DC Plate Current:			
Peak of envelope.	205		ma
Average.	150		ma
DC Grid-No.2 Current:			
Peak of envelope.	16		ma
Average.	10		ma
Average DC Grid-No.1 Current.	1 ^h		ma
Peak-of-Envelope Driver Power			
Output (Approx.) ^j	0.3		watt
Output-Circuit Efficiency (Approx.) . . .	95		%
Distortion Products Level: ^k			
Third order.	30		db
Fifth order.	35		db
Useful Power Output (Approx.):			
Peak of envelope.	80 ^m		watts
Average.	40 ^m		watts



Maximum Circuit Values:Grid-No.1-Circuit Resistance
under any condition:With fixed bias 25000 max. ohms
With fixed bias (In Class-AB₁
operation). 100000 max. ohms

With cathode bias Not recommended

Grid-No.2-Circuit Impedance 10000 ohms

Plate-Circuit Impedance n

**RF POWER AMPLIFIER & OSCILLATOR — Class C Telegraphy
and****RF POWER AMPLIFIER — Class C FM Telephony****Maximum CCS Ratings, Absolute-Maximum Values:***Up to 500 Mc*

DC PLATE VOLTAGE. 2200 max. volts

DC GRID-No.2 VOLTAGE. 400 max. volts

DC GRID-No.1 VOLTAGE. -100 max. volts

DC PLATE CURRENT. 300 max. ma

DC GRID-No.1 CURRENT. 100 max. ma

GRID-No.2 DISSIPATION 8 max. watts

PLATE DISSIPATION 100^f max. watts

PEAK HEATER-CATHODE VOLTAGE:

Heater negative with
respect to cathode. 150 max. voltsHeater positive with
respect to cathode. 150 max. volts**Typical CCS Operation:***In grid-drive circuit
at frequency of**50**175**470**Mc*

DC Plate Voltage. 500 700 500 700 700 volts

DC Grid-No.2 Voltage. . . 160 175 200 200 200 volts

DC Grid-No.1 Voltage. . . -10 -10 -30 -30 -30 volts

DC Plate Current. 300 300 300 300 300 ma

DC Grid-No.2 Current. . . 25 25 30 20 10 ma

DC Grid-No.1 Current. . . 50 50 40 40 20 ma

Driver Power Output

(Approx.)^p. 1.2 1.2 3 3 5 watts

Useful Power Output:

Typical 85^m 110^m 70^m 105^m 85^m wattsFor minimum useful-
power output see*Characteristics Range**Values, Test. No.8 No.9 No.10***Maximum Circuit Values:**Grid-No.1-Circuit Resistance
under any condition:

With fixed bias 25000 max. ohms

Grid-No.2-Circuit Impedance 10000 max. ohms

Plate-Circuit Impedance n



- a Because the cathode is subjected to back bombardment as the frequency is increased with resultant increase in temperature, the heater voltage should, for optimum life, be reduced to a value such that at the heater voltage obtained at minimum supply voltage conditions (all other voltages constant) the tube performance just starts to show some degradation; e.g., at 470 Mc, heater volts = 12.5 (Approx.).
- b Measured with special shield adapter.
- c Mycalex Corporation of America, 125 Clifton Boulevard, Clifton, New Jersey.
- d For use at higher frequencies.
- e The maximum rating for a signal having a minimum peak-to-average power ratio less than 2, such as is obtained in "Single-Tone" operation, is 300 ma. During short periods of circuit adjustment under "Single-Tone" conditions, the average plate current may be as high as 450 ma.
- f Maximum plate dissipation is limited by the maximum plate core temperature and the cooling system to maintain tube operation below the specified maximum plate core temperature. With simple low-cost cooling techniques, maximum plate dissipation may be only about 100 watts; with more sophisticated cooling techniques, maximum plate dissipation may be as high as 300 watts.
- g Obtained preferably from a separate, well-regulated source.
- h This value represents the approximate grid-No.1 current obtained due to initial electron velocities and contact-potential effects when grid No.1 is driven to zero volts at maximum signal.
- j Driver power output represents circuit losses and is the actual power measured at input to grid-No.1 circuit. The actual power required depends on the operating frequency and the circuit used. The tube driving power is approximately zero watts.
- k With maximum signal output used as a reference, and without the use of feedback to enhance linearity.
- m The value of useful power is measured at load of output circuit.
- n The tube should see an effective plate supply impedance which limits the peak current through the tube under surge conditions to 15 amperes.
- p Driver power output includes circuit losses and is the actual power measured at the input to the grid circuit. It will vary depending upon the frequency of operation and the circuit used.

CHARACTERISTICS RANGE VALUES

Test No.	Note	Min.	Max.	
1. Heater Current	1	1.15	1.45	amp
2. Direct Interelectrode Capacitances:	2			
Grid No.1 to plate . .	-	-	0.13	μmf
Grid No.1 to cathode .	-	14.3	17.7	μmf
Plate to cathode . . .	-	0.0065	0.0155	μmf
Grid No.1 to grid No.2	-	19.8	24.2	μmf
Grid No.2 to plate . .	-	5.7	7.1	μmf
Grid No.2 to cathode .	-	2.6	3.6	μmf
Cathode to heater. . .	-	2.5	4.1	μmf
3. Grid-No.1 Voltage. . . .	1,3	-8	-19	volts
4. Reverse Grid-No.1 Current.	1,3	-	-25	μa
5. Grid-No.2 Current. . . .	1,3	-7	+6	ma
6. Peak Emission.	1,4	13	-	peak amp
7. Interelectrode Leakage Resistance	5	1	-	megohm
8. Useful Power Output. . .	1,6	90	-	watts
9. Useful Power Output. . .	1,7	85	-	watts
10. Useful Power Output. . .	1,8	75	-	watts
11. Cutoff Grid-No.1 Voltage	1,9	-	-44	volts



- Note 1: With 13.5 volts ac or dc on heater.
- Note 2: Measured with special shield adapter.
- Note 3: With dc plate voltage of 700 volts, dc grid-No.2 voltage of 250 volts, and dc grid-No.1 voltage adjusted to give a dc plate current of 185 ma.
- Note 4: For conditions with grid No.1, grid No.2, and plate tied together; and pulse voltage source connected between plate and cathode. Pulse duration is 2.5 microseconds and pulse repetition frequency is 60 pps. The voltage-pulse amplitude is 200 volts peak. After 1 minute at this value, the current-pulse amplitude will not be less than the value specified.
- Note 5: Under conditions with tube at 20° to 30° C for at least 30 minutes without any voltages applied to the tube. The minimum resistance between any two electrodes as measured with a 200-volt Megger-type ohmmeter having an internal impedance of 1 megohm, will be 1 megohm.
- Note 6: In a CW grid-driven, conduction-cooled amplifier circuit at 50 Mc and for conditions: dc plate voltage of 700 volts, grid-No.1 voltage of -10 volts, driver power output of 1.2 watts, and grid-No.2 voltage varied to obtain a plate current of 300 ma.
- Note 7: In a CW grid-driven, conduction-cooled amplifier circuit at 175 Mc and for conditions: dc plate voltage of 700 volts, grid-No.1 voltage of -30 volts, driver power output of 3 watts, and grid-No.2 voltage varied to obtain a plate current of 300 ma.
- Note 8: In a CW grid-driven, conduction-cooled amplifier circuit at 470 Mc and for conditions: dc plate voltage of 700 volts, grid-No.1 voltage of -30 volts, driver power output of 5 watts, and grid-No.2 voltage varied to obtain a plate current of 300 ma.
- Note 9: With dc plate voltage of 700 volts, dc grid-No.2 voltage of 250 volts, and dc grid-No.1 voltage varied to obtain a plate current of 5 ma.

COOLING CONSIDERATIONS

The conduction-cooling system consists, in general, of a constant temperature device (heat sink) and suitable heat-flow path (coupling device) between the heat sink and tube. Primary consideration of the system should be given to the design of a heat-flow path (coupling device) with high thermal conductivity.

Thermal conductivity^q may be calculated from the equation:

$$K = \frac{W}{A \frac{(T_2 - T_1)}{L}} \quad (1)$$

where;

- K = thermal conductivity of the material
- W = power transfer in watts
- A = area measured at right angles to the direction of the flow of heat in square inches
- T₁, T₂ = temperature in degrees Centigrade of planes or surfaces under consideration
- L = length of heat path in inches through coupling material to produce temperature gradient

^q Thermal conductivity is defined as the time rate of transfer of heat by conduction, through unit thickness, across unit area for unit difference of temperature. It is measured in watts per square inch for a thickness of one inch and a difference of temperature of 1° C.



For a given system Equation (1) must be integrated to consider changes in area (A) dependent on the coupling configuration and changes in thermal conductivity (K) dependent on various coupling materials and interfaces. Equation (1) may now be reduced to the following:

$$K_S = \frac{W_P}{T_2 - T_1} \quad (2)$$

where;

K_S = thermal conductance of the system

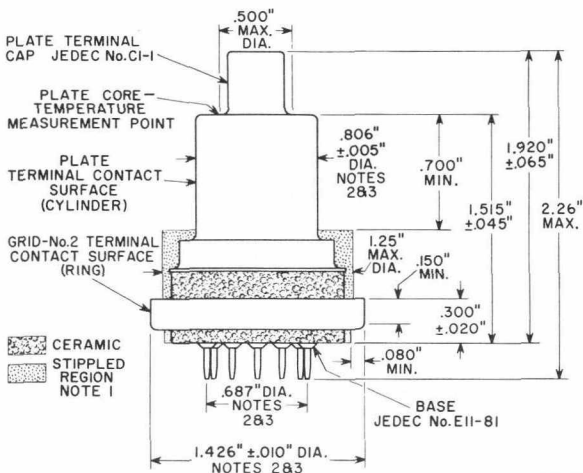
W_P = maximum permissible plate dissipation in watts

T_2 = temperature in degrees Centigrade at tube terminal

Note: This value may never exceed the specified maximum rating for terminal temperature.

T_1 = temperature in degrees Centigrade of heat sink





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NOTE 1: KEEP ALL STIPPLED REGIONS CLEAR. DO NOT ALLOW CONTACTS OR CIRCUIT COMPONENTS TO PROTRUDE INTO THESE ANNULAR VOLUMES.

NOTE 2: THE DIAMETERS OF THE PLATE TERMINAL CONTACT SURFACE, GRID-No.2 TERMINAL CONTACT SURFACE, AND PIN CIRCLE TO BE CONCENTRIC WITHIN THE FOLLOWING VALUES OF MAXIMUM FULL INDICATOR READING:

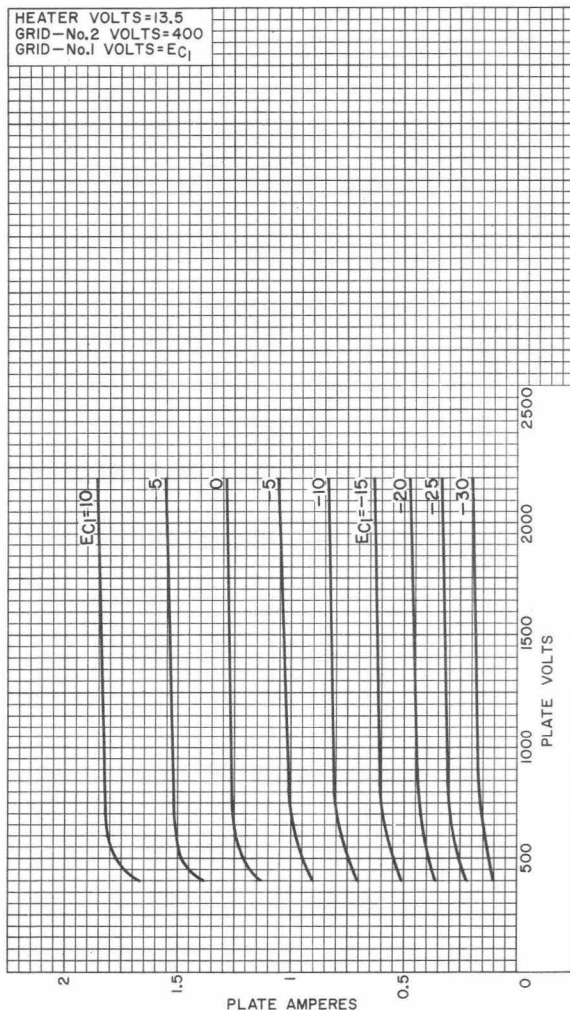
Plate Terminal Contact Surface	
to Grid-No.2 Terminal Contact Surface.	0.030"
Plate Terminal Contact Surface	
to Pin Circle.	0.040"
Grid-No.2 Terminal Contact Surface	
to Pin Circle.	0.030"

NOTE 3: THE FULL INDICATOR READING IS THE MAXIMUM DEVIATION IN RADIAL POSITION OF A SURFACE WHEN THE TUBE IS COMPLETELY ROTATED ABOUT THE CENTER OF THE REFERENCE SURFACE. IT IS A MEASURE OF THE TOTAL EFFECT OF RUN-OUT AND ELLIPTICITY.



TYPICAL PLATE CHARACTERISTICS

HEATER VOLTS=13.5
GRID—No.2 VOLTS=400
GRID—No.1 VOLTS= E_{C1}

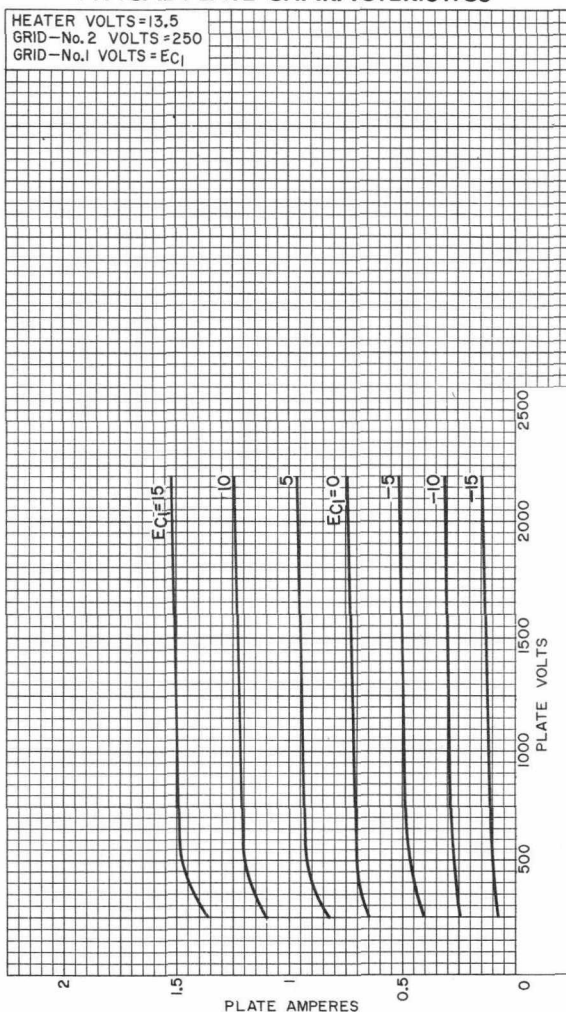


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TYPICAL PLATE CHARACTERISTICS

HEATER VOLTS = 13.5
GRID—No. 2 VOLTS = 250
GRID—No. 1 VOLTS = E_{C1}



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RADIO CORPORATION OF AMERICA
Electron Tube Division

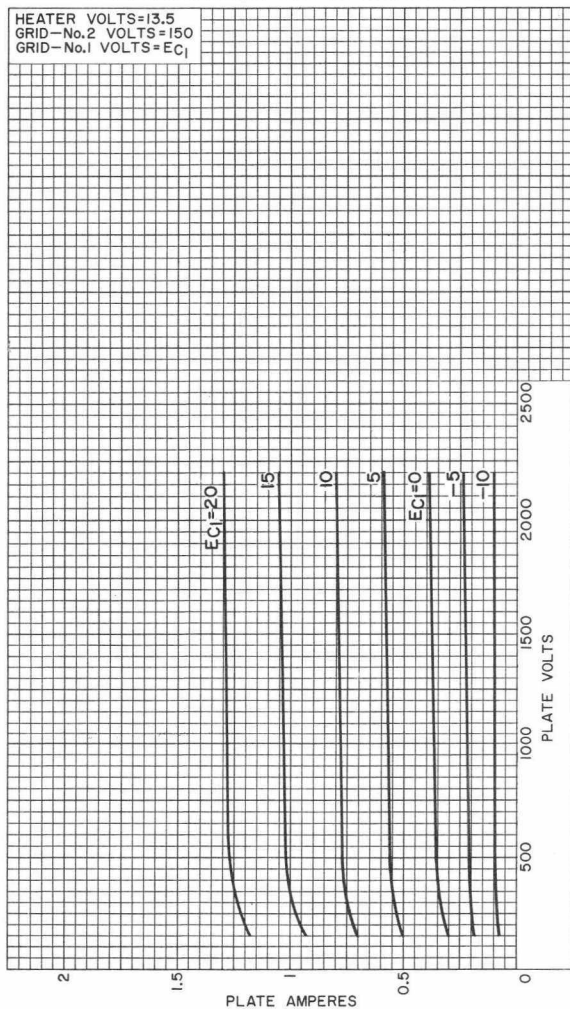
Harrison, N. J.

DATA 5
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TYPICAL PLATE CHARACTERISTICS

HEATER VOLTS=13.5
 GRID—No.2 VOLTS=150
 GRID—No.1 VOLTS= E_{C1}

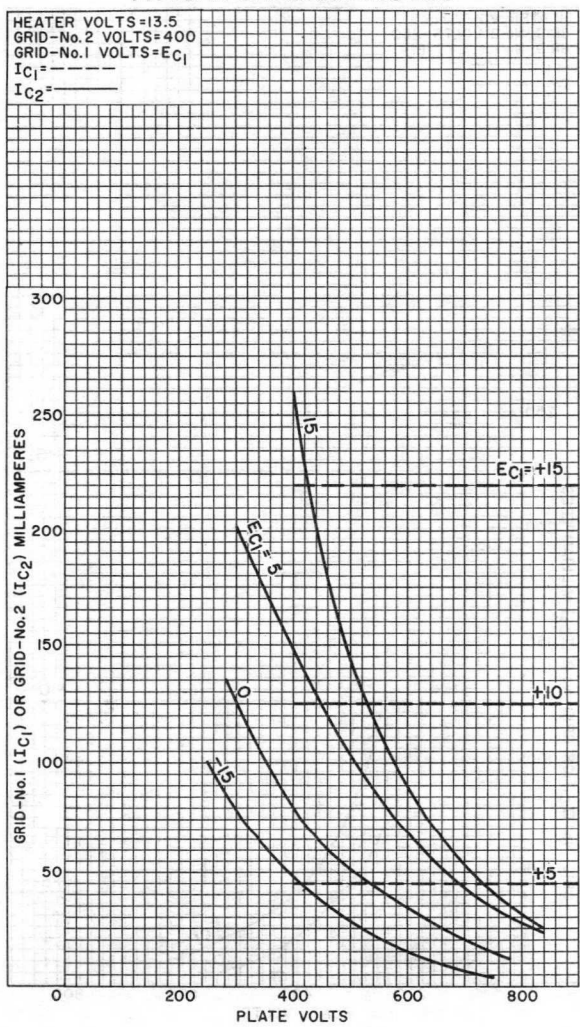


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TYPICAL CHARACTERISTICS

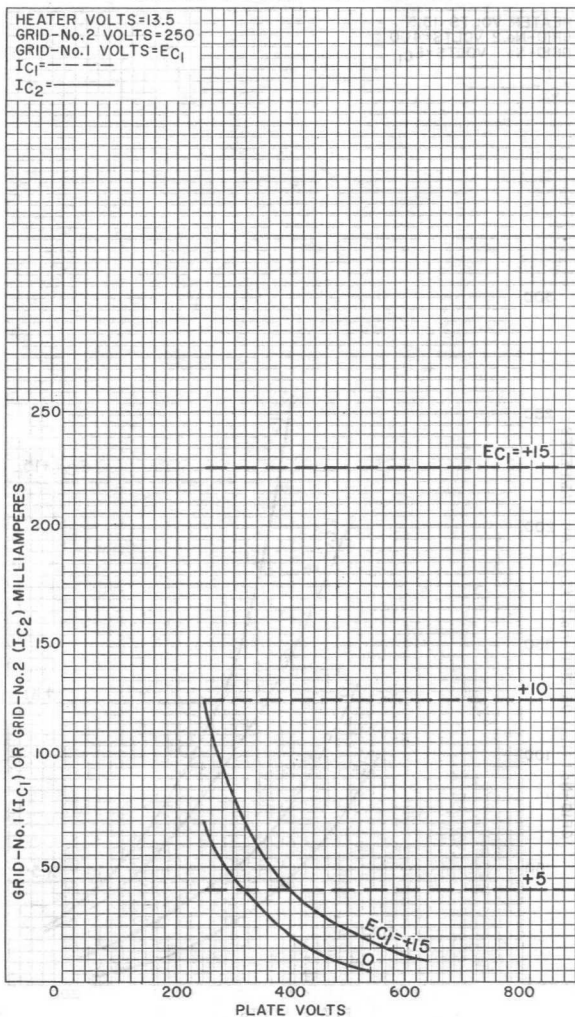
HEATER VOLTS=13.5
 GRID-No. 2 VOLTS=400
 GRID-No.1 VOLTS= E_{C1}
 I_{C1} = -----
 I_{C2} = -----



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TYPICAL CHARACTERISTICS

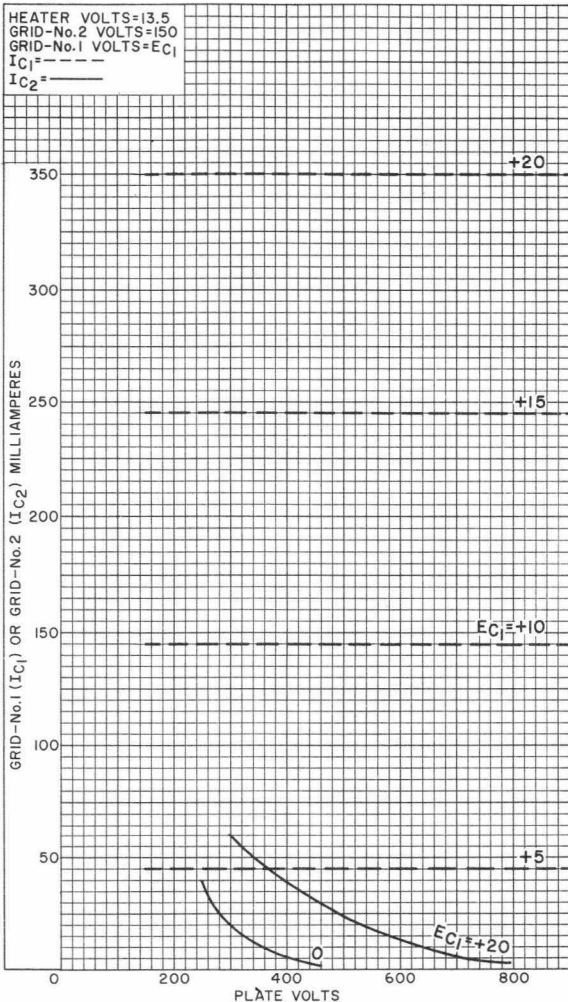


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TYPICAL CHARACTERISTICS



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